# Directi
# Find

BY USING a rotatable ferrite rod aerial, advantage can be taken of its directional properties, either to obtain best reception of a station without needing to turn the receiver itself, or to obtain a directional bearing from a transmitter. The receiver described here is completely screened except for the rotatable aerial, and uses a telescopic aerial which can be brought into use if wanted. The latter is for "sense" determination, to remove the

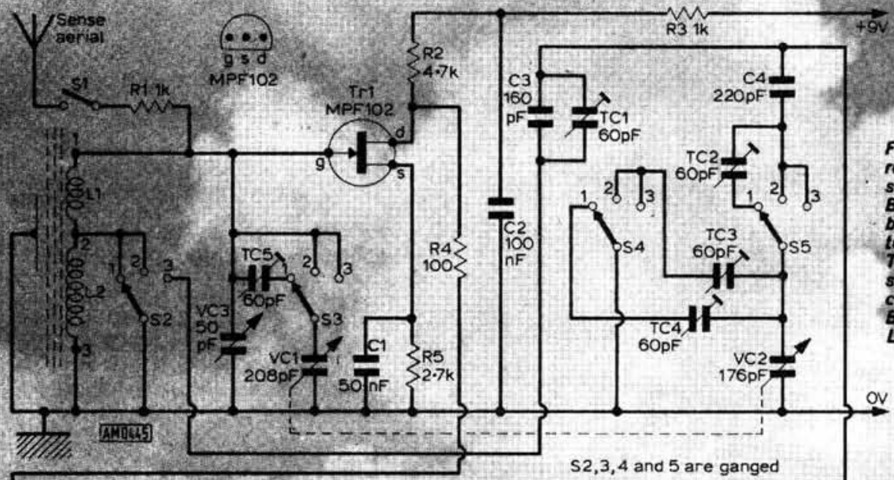


*Fig. 1: Front end of the receiver containing the sense and ferrite aerials. Bandswitching is achieved by means of S2-5, and tuning by means of VC1/2. The MW band has been split into two parts, Band 1 covers 1300–1500kHz and Band 2 600–1300kHz. On LW Band 3 covers 160–250 kHz.*

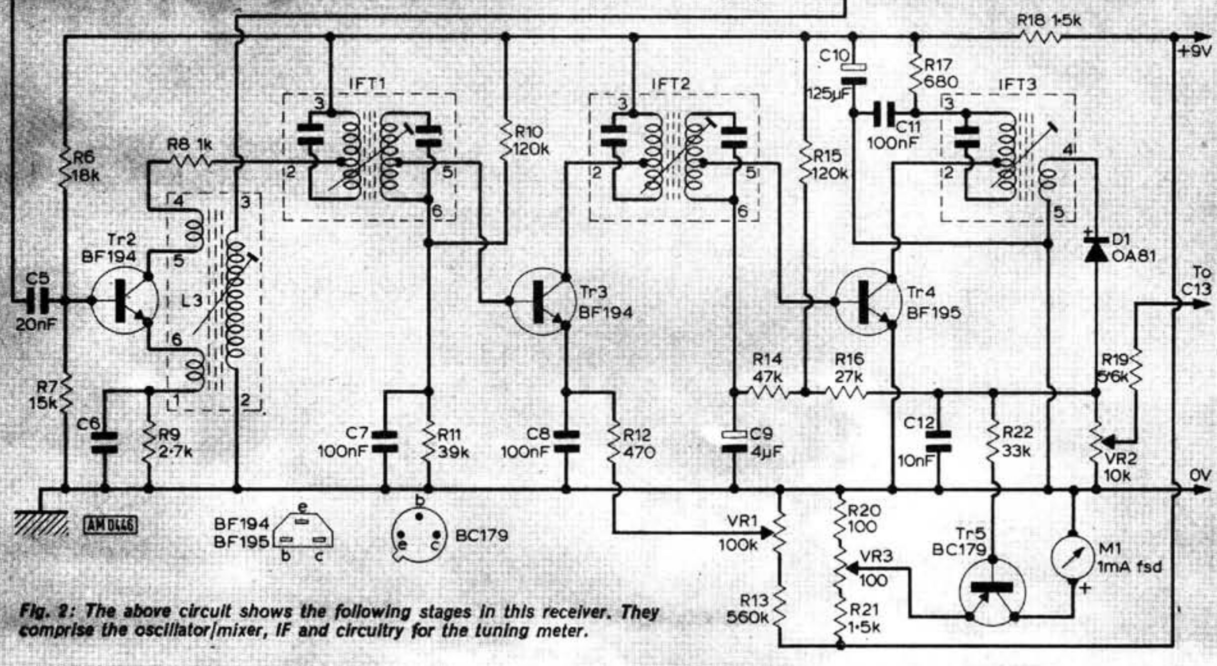


*Fig. 2: The above circuit shows the following stages in this receiver. They comprise the oscillator/mixer, IF and circuitry for the tuning meter.*

180° ambiguity which exists with the ferrite rod aerial alone.

The ferrite aerial has **two** maximum signal strength positions, with the rod at right angles to the direction of the transmitter; and **two** minimum positions, with the rod in line with the transmitter. These positions are shown by a panel meter. In many circumstances, as with European or other stations, the approximate direction will be known. In other circumstances the correct direction may not be known.

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F. G. RAYER


The sense aerial is then used to provide another signal. With one position of the ferrite rod, signals from both aerials will combine, giving a greater meter deflection than the other position, where ferrite aerial and sense aerials are out of phase. By this means it is possible to find which bearing is correct of the two minimum readings obtained without the sense aerial.

## RF and Tuning

Fig. 1 is the circuit of the aerial, RF and oscillator tuning arrangements. L1 and L2 are MW and LW sections on the ferrite rod, which is assembled on a jack plug. This fits into a socket, through a hole in the top of the case. S1 allows the sense aerial to be connected. S2/3/4/5 are the four poles of a 3-way switch. Positions 1 and 2 of section S2, short L2, for MW reception. Position 3 introduces C3 and TC1 to load the oscillator coil L3 for LW reception. Sections S3 and S5 introduce series capacitors TC5 and TC2 in position 1, to spread the tuning at the high frequency end of the MW band. S4 connects trimmer TC4 for this band, and trimmer TC3 for the lower frequency bands.

To avoid the need for further aerial trimmers and to allow correct trimming with S1 open or closed, a panel trimmer VC3 is used for aerial circuits. Tr1 avoids the need for a coupling winding on the ferrite aerial, which would require four connections in all. A 3-way jack plug and socket may thus be used. Point 1 is the inner (tip), point 2 the centre and point 3 the outer sleeve. Tr1, together with its associated circuitry is fitted to a tag strip near the jack socket as in Fig. 1.

## IF Circuit

Fig. 2 gives details of the IF circuitry, which comprises the oscillator/mixer Tr2, two IF amplifiers Tr3 and Tr4, and detector D1. External connections to Tr2 go from R4 to C5 with a lead from pin 3 of the oscillator coil, to C3, TC1 and C4, Fig. 1. R8 is under the board, from pin 4 to pin 2.

As strong signals can give more than full-scale on the tuning meter, the 1st IF amplifier Tr3 is arranged to have the manual gain control VR1. This can be adjusted to bring the meter back to a central position, when required, as well as controlling IF gain. Bias from D1 is thus applied for automatic gain control purposes to Tr4, via R14 and R16. The meter is positioned to one side of the tuning scale, while the meter amplifier Tr5, is assembled on a tag strip secured to the dial plate. Trimmer pot VR3 is set so that the meter reading is just beginning to rise, with no signal. Increasing signal strength then causes negative base bias to Tr5 to raise collector current, so that the meter reading rises. Maximum meter reading corresponds to maximum signal strength, when rotating the aerial or VC3. With VR1 set so that this is about half-scale on the meter, the directional null should give almost zero reading on the meter, and is used for bearings, as it is sharper than the maximum.

Audio from the volume control VR2 passes to the AF amplifier.

## Audio Amplifier

The AF amplifier comprises pre-amplifier, driver and output stages, Fig. 3, and uses few components and easily obtained transistors. The most suitable

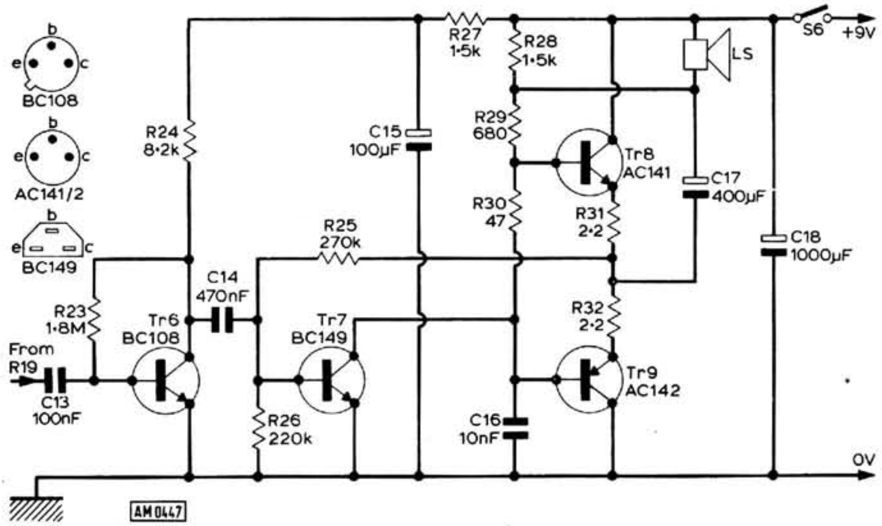



*Fig. 3: This shows the circuit for the audio amplifier, which uses for its output a matched pair of AC141/2 transistors. Speaker impedance should be around 15Ω.*

speaker impedance is about 15Ω, although the actual value is not too important. However, a speaker of less than about 10Ω ought not to be used, unless pressed into service by including a series resistor to make up the total, while speakers of over about 25Ω will result in some saving on battery current, but reduction in output.

## Chassis and Panel

Holes are drilled in the front of the chassis as in Fig. 4. For the cabinet listed, allow the panel to project below the chassis about ½in and mark the hole positions on it. The 7×2½in scale plate is bolted a little back from the panel, which is not fitted until later. Fit the ganged capacitor with 4BA bolts, noting it is essential to use short bolts, or add washers, so that they do not project beyond the thickness of the metal plate. Two small pulleys are pivoted on 4BA bolts, held with lock nuts to the plate. The cord passes twice round the drum, and then round the small wheels, and is held taut by a spring. Drill a hole in the panel for the slow-motion spindle of the capacitor. The pointer is a straight wire soldered to a small piece of tinplate, which is clipped on the cord. Arrange this so that it is fully to the right with VC1/2 closed and the spring to the left.

The case requires two ¾in diameter holes. One is placed centrally, for the ferrite aerial, and the other near the back right hand corner, for the telescopic aerial. Using a universal chassis flanged runner, 8×1in, cut sections from each flange 3in from the ends, so that it can be bent to form the mount shown in Fig. 5. This is bolted to the chassis so that the jack socket comes under the central hole in the case.

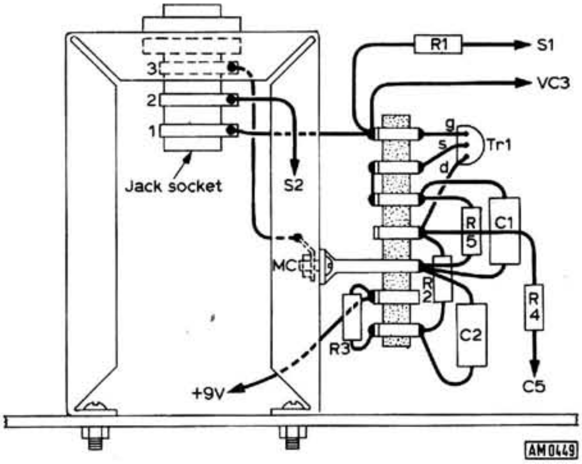



*Fig. 5: The mounting for the rotating aerial, and the tag strip that holds the RF stage, is constructed from a Universal chassis flanged runner and bent to fit.*

Should a little adjustment of height be required so that the jack socket will clear the top of the case, the legs of this metal part can be spread outwards to lower it. Check that there is sufficient space for the IF board between the mount and scale plate.

The sense aerial must be insulated from the chassis. This was arranged by punching a 1in diameter hole, over which a piece of paxolin is fixed with 6BA screws. The bolt on which the aerial screws fits vertically in the paxolin, and a lead runs from it to S1. If necessary, the paxolin can be spaced from the chassis, either above or below, so that the aerial closes flush with the case top. This aerial is run on to its screw after placing the receiver in its case.

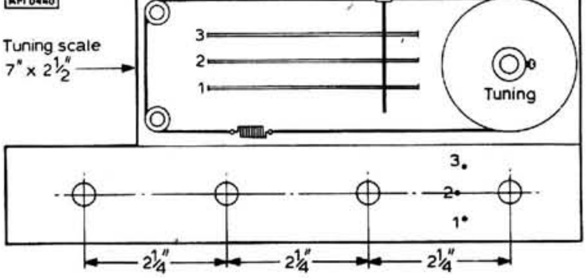



*Fig. 4: Details of the scale card, and the spacings required for the variable control positions.*

The internal speaker is mounted on the left side of the cabinet. A grid of nine ¾in holes was punched over the position to be occupied by the cone. An alternative is to cut a larger hole and cover this with fabric or expanded metal. A 4×1½in opening is cut in the panel, and is covered by a slightly larger

## ★ components list

**Resistors**

| | | | |
|---|---|---|---|
| R1 | 1kΩ | R17 | 680Ω |
| R2 | 4·7kΩ | R18 | 1·5kΩ |
| R3 | 1kΩ | R19 | 5·6kΩ |
| R4 | 100Ω | R20 | 100Ω |
| R5 | 2·7kΩ | R21 | 1·5kΩ |
| R6 | 18kΩ | R22 | 33kΩ |
| R7 | 15kΩ | R23 | 1·8MΩ |
| R8 | 1kΩ | R24 | 8·2kΩ |
| R9 | 2·7kΩ | R25 | 270Ω |
| R10 | 120kΩ | R26 | 220kΩ |
| R11 | 39kΩ | R27 | 1·5kΩ |
| R12 | 470Ω | R28 | 1·5kΩ |
| R13 | 560Ω | R29 | 680Ω |
| R14 | 47kΩ | R30 | 47Ω |
| R15 | 120kΩ | R31 | 2·2Ω |
| R16 | 27kΩ | R32 | 2·2Ω |

All resistors 5% ¼W
VR1 100kΩ linear potentiometer
VR2 10kΩ log. potentiometer with switch S6
VR3 100Ω pre-set potentiometer

**Capacitors**

| | | | |
|---|---|---|---|
| C1 | 50nF | C10 | 125μF |
| C2 | 100nF | C11 | 100nF |
| C3 | 160pF 2% silver mica | C12 | 10nF |
| C4 | 220pF 2% silver mica | C13 | 100nF |
| C5 | 20nF | C14 | 470nF |
| C6 | 2nF | C15 | 100μF 10V |
| C7 | 100nF | C16 | 10nF |
| C8 | 100nF | C17 | 470μF 6V |
| C9 | 4μF 4V | C18 | 1000μF 10V |

VC1/2 Jackson 00 208/176pF slow motion gang
VC3 Jackson C804 50pF
TC1-TC5 60pF trimmers

**Semiconductors**

| | | | |
|---|---|---|---|
| Tr1 | MPF102 | Tr6 | BC108 |
| Tr2 | BF194 | Tr7 | BC149 |
| Tr3 | BF194 | Tr8 | AC141 |
| Tr4 | BF195 | Tr9 | AC142 |
| Tr5 | BC179 | D1 | OA81 |

**Miscellaneous**

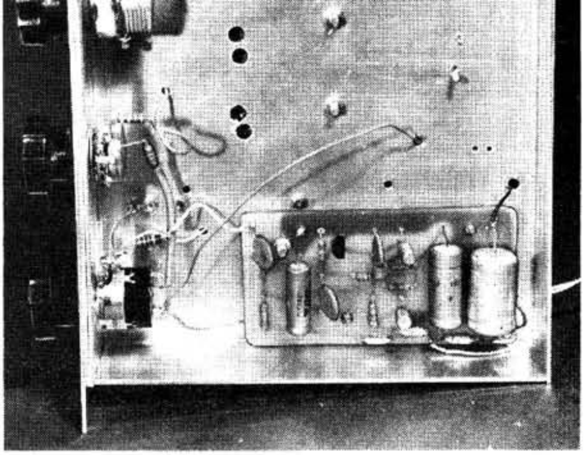
L1/L2, Denco MW/LW 5FR. IFT1, Denco IFT18/465. IFT2, Denco IFT18/465. IFT3, Denco IFT14.L3, Osc. coil Denco TOC1. S1, miniature slide switch. S2-S5 4-pole 3-way rotary switch. Moving coil meter 1mA fsd 42 x 42mm. Jackson 54mm diameter drum. Paxolin tube 150 x 29mm diameter. 6mm stereo jack socket. 5 control knobs. 550mm telescopic rod aerial. 6mm stereo jack plug. 15Ω speaker. 156mm dia. 360 degree protractor. Plastic bowl 156 x 30mm. OSC/IF PCB, 105 x 55mm. AF PCB, 129 x 55mm. Both boards available from the PW Readers PCB Service, page 1070.

**Case**

Type W case 10 x 7 x 5½in. Type K chassis 9 x 6¾ x 1½in. Type A screen 7 x 2¼ x ½in. All HL Smith & Co. 8 x 1in. flanged Universal chassis runner—Home Radio Ltd.

piece of 1/16in Perspex, held with two screws. A card scale, upon which three lines have been drawn, is fixed with adhesive, so that the three bands can be calibrated later.

A bracket is bent from scrap metal to hold the PP7 battery and is screwed down behind the aerial mount. Do not overlook that holes are required under IFT1 and IFT2, so that the lower cores can be reached. These are simply positioned by marking them through the circuit board before fitting the IFT's.

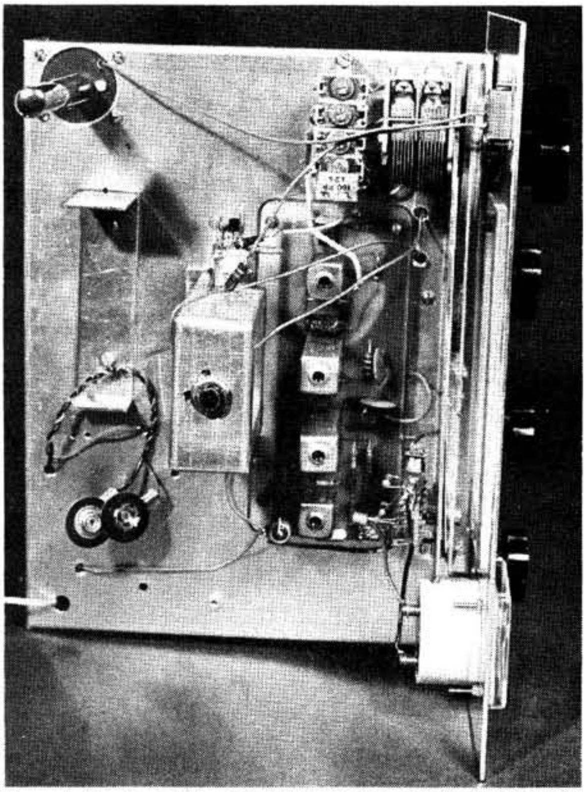


*Underside view of chassis, showing the volume control, IF gain and aerial trim controls. The PCB in the lower righthand corner is the Audio board.*

## RF Stage

The RF circuit is wired as in Fig. 5, which also shows connections to the jack socket. Leads are fitted to run to S1, VC3, C5, battery positive line and S2. The jack plug and socket, S1 and aerial, as well as VC3, contribute to the stray capacitance across L1 and L2 so when wiring, these unavoidable capacitances should be kept as low as possible, otherwise there may be difficulty in reaching the HF end of the range.

With individual samples of Tr1 it is possible that changes to the resistors R2 and R5 could improve gain. Otherwise the values given should be suitable. R4 may be the lowest value which does not allow instability to develop.



*General plan view photograph of the receiver, showing layout of the Osc/IF board, tuning capacitor and trimmers, and the rotating aerial mounting.*

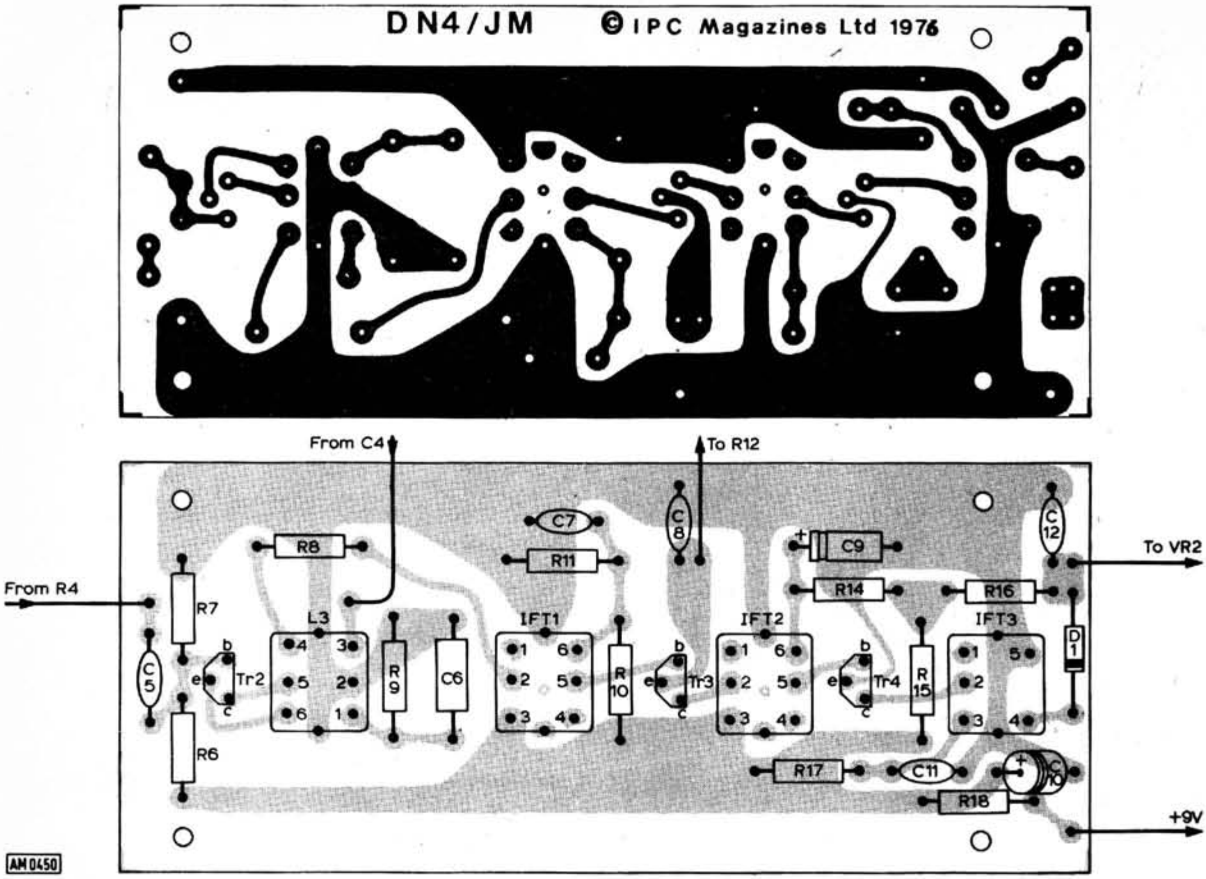



*Fig. 6: Foil side and component side views of the Osc/IF board. Both are shown full size. If the board is to be tested outside the receiver, VR2 must be connected*

## Osc/IF Board

Fig. 6 shows the PCB carrying the Osc/IF sections of the receiver. The input goes to C5 and the output taken from D1. The oscillator coil and IFTs should fit without any need to use force. If not, the holes for these may be slightly enlarged, taking care not to break the foil. Components are inserted as in Fig. 6, excess length of wire being snipped off after soldering. Provide flying leads for input, output, battery positive (S6), meter amplifier and IF gain control. (If this board is tested before fitting, VR2 must be connected.) Mounting is by means of four ½in 6BA bolts, with extra nuts to give spacing from the chassis and locked firmly to provide the necessary chassis return.

Since the gain of individual transistors varies, it might be possible to modify the value of R8, using the lowest value which does not result in uncontrollable oscillation at any frequency. Normally, however, the value given can be fitted.

## Audio Amplifier

The AF board is shown in Fig. 7. Colour coded leads can be soldered on for R19, speaker and battery positive. The PCB is mounted under the chassis with three bolts, with the speaker leads made long enough to allow the receiver to come well out of the case. If a jack socket is used here, it must be completely insulated from the chassis or be of the insulated type.

## Meter Amplifier

Components for the meter amplifier are wired to the tag strip as in Fig. 8. The meter is a 1mA instrument calibrated in S-points, though the meter is primarily required to show minimum signal positions for the rotating ferrite rod aerial. If after maximum adjustments to VR3 the meter cannot be set so that it is just beginning to rise, with no signal tuned in, then either R20 or R21 may be changed in value, to correct this. Alternatively, R3 can be changed to 250Ω, provided R20, VR3 and R21 in series total about 1·5 to 2kΩ. It does not matter how the potential divider is made up, except that adjustment of VR3 becomes more critical if it forms most of the total resistance.

## Bandswitch

Connections to the switch are shown in Fig. 9, and can be followed in conjunction with Fig. 1. The rotor tag of VC3 must be wired to the chassis. TC5 is soldered directly across the switch, while the four trimmers TC1 to TC4 are mounted on a strip fixed

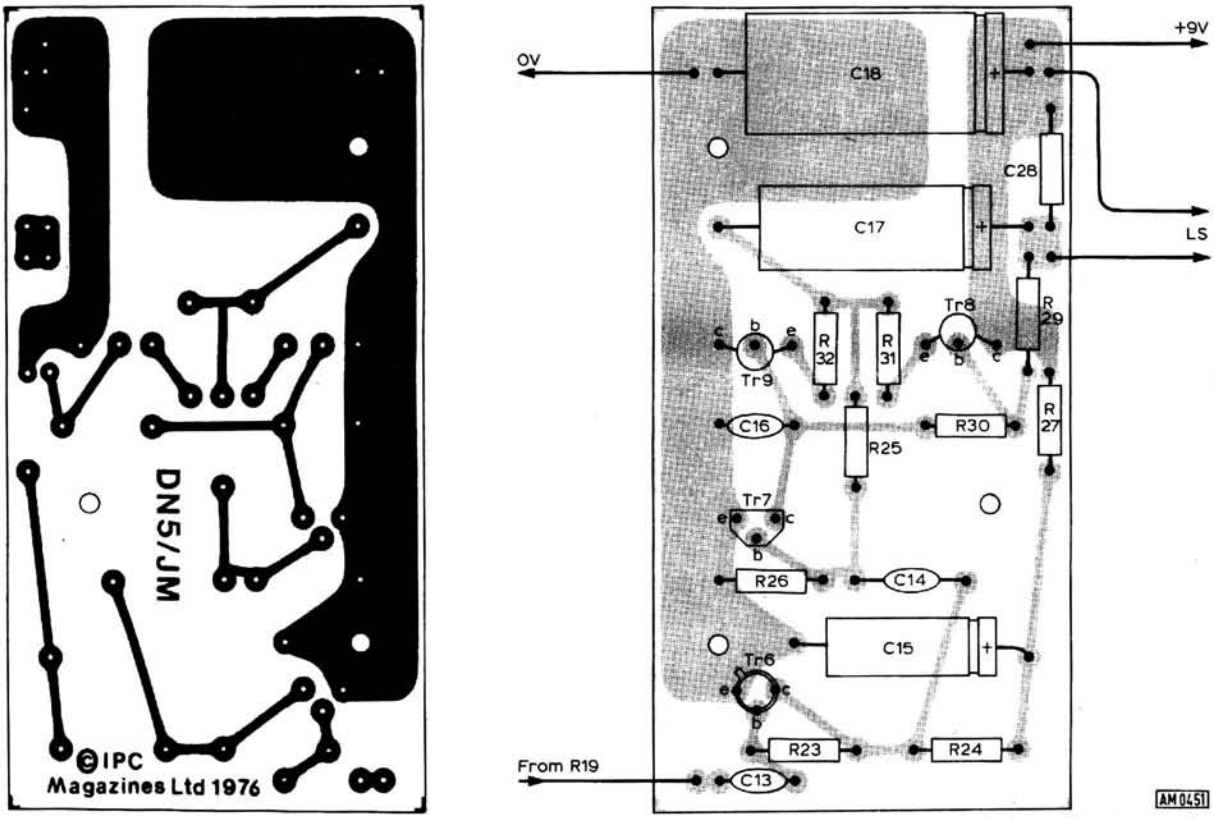



*Fig. 7: Audio amplifier board showing the foil side to the left and the component side to the right. Again, both are shown full size. Chassis mounting is by three bolts.*

clear of the chassis, by spacers, and behind VC1/2. It is convenient to use these trimmers, from left to right, for the circuit positions in Fig. 1. That is, TC1 LW oscillator trimmer; TC2 Range 1 bandspread coverage; TC3 Range 2 (and LW) oscillator trimmer; and TC4 Range 1 trimmer. This allows a short lead to run from pin 3 of the oscillator coil to TC1 and C4, which is connected from TC1 to TC2. For short leads, use the lower tags of VC1 and VC2, as in Fig. 10.

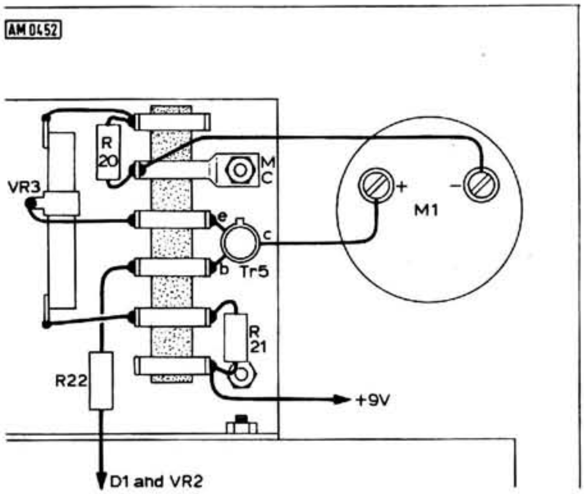



*Fig. 8: Components that make up the meter amplifier are mounted on a tag strip adjacent to the meter itself. VR3 can be any pre-set pot of 100Ω.*

## Rotating Aerial

A 3-way jack plug is used as a pivot and is assembled as in Fig. 11. A $4\frac{1}{4}$in disc is cut from plywood (this diameter was chosen to suit the diameter of the 0·360° protractor and is a tight push fit on the insulated part of the jack, to which it is cemented. If necessary, a block with a central hole can be glued here to strengthen the assembly. Insulated thin flexible leads are soldered to the plug contacts; these may be green for 1, red for 2, and black for 3. Thread these wires up through the jack moulding and bring them out on top of the disc.

The ferrite rod aerial as received has a few turns for base coupling to L1 and these are removed. L1 and L2 must be in the same phase when connected in series, or LW alignment is impossible. The rod is secured to a small piece of paxolin by thread and

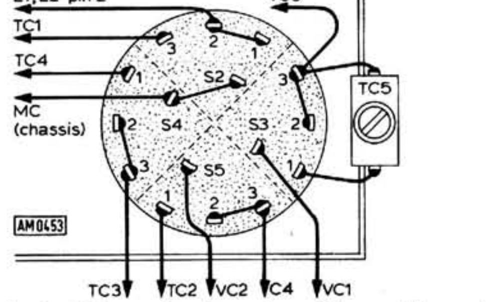



*Fig. 9: The band switch comprises four poles and three positions, and the above drawing shows the connections to this switch, and the trimmer TC5.*

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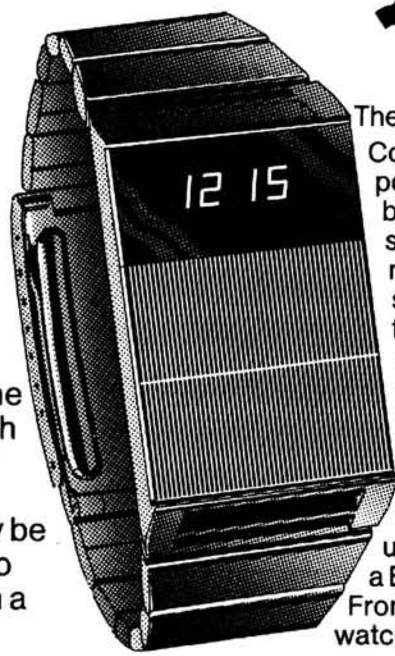


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* **Complete**–right down to strap and batteries.
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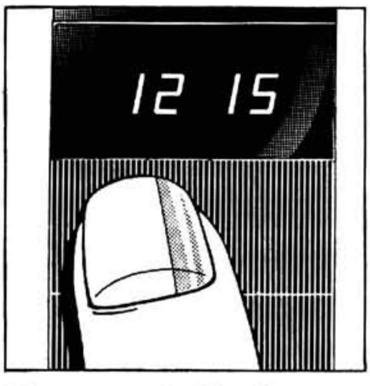
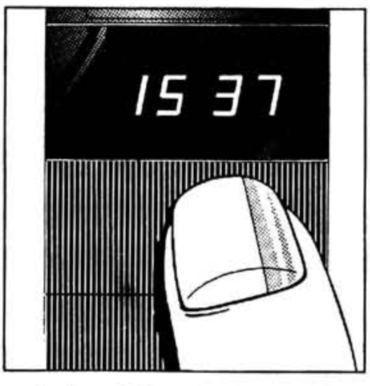



**here for minutes and seconds.**

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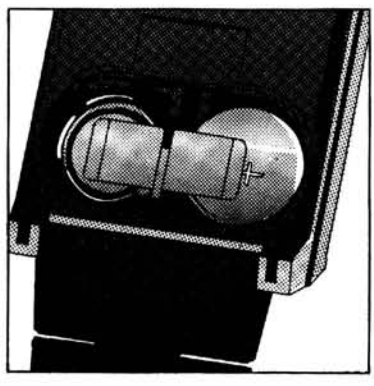

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b) divider chain
c) decoder circuits
d) display inhibit circuits
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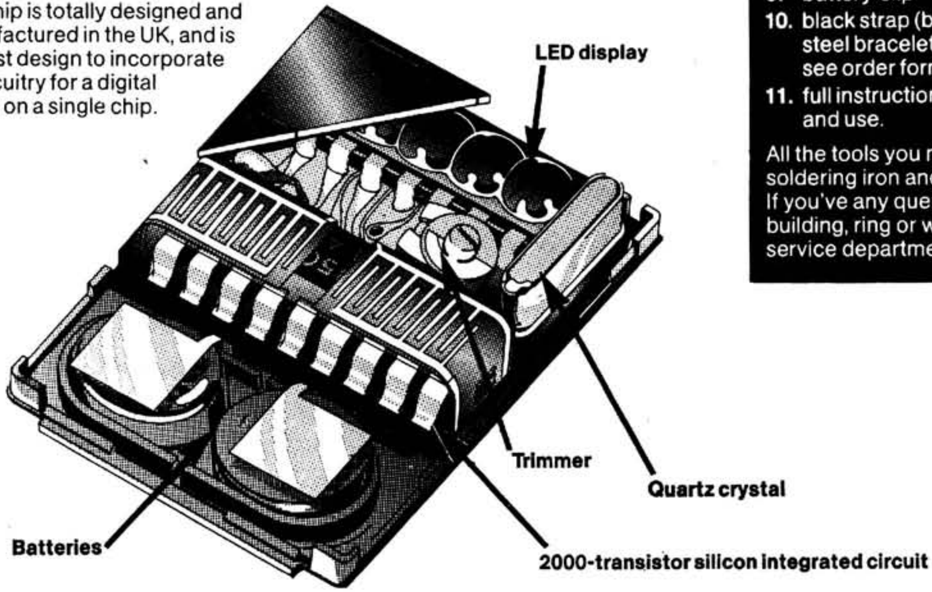


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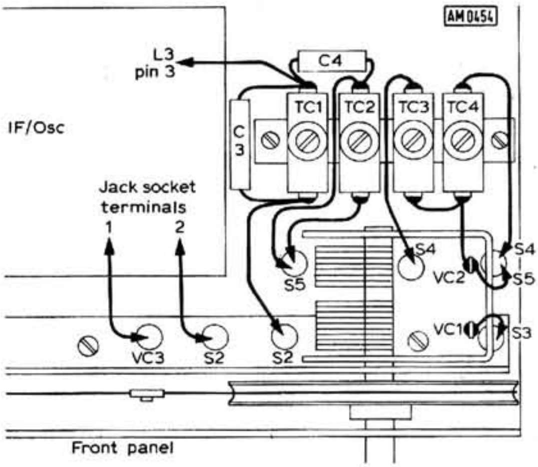


*Fig. 10: The trimmers TC1 to TC4 are mounted in the above configuration to enable the leads to be kept as short as possible.*

adhesive. This is held with two small screws, with strips to space it slightly from the disc, to clear the plug leads. These are soldered to the appropriate leads from L1 and L2, using pins as anchorage points if required. When the aerial has been tested, it is protected by a 6×1in paxolin tube, cut away just sufficiently on the underside to allow it to be fitted over the rod. A lead from point 3 is brought out from the tube.

The metal shield is bent from aluminium, about $3\frac{1}{2}\times2$in, to clamp the paxolin to the wooden disc and it is earthed by a tag under one fixing screw, soldered to lead 3. Its purpose is to improve the minimum null by reducing non-directional pick-up by the connecting wires. Approximate alignment can be made before fitting the paxolin tube. Final small adjustments to the positions of L1 and L2 may be made with an insulated tool, through the open ends of the tube. The ends of the tube may be closed with discs of insulating material. Due to stray pick-up by other wiring, the sharpest directional nulls are obtained only with the receiver in its metal cabinet.

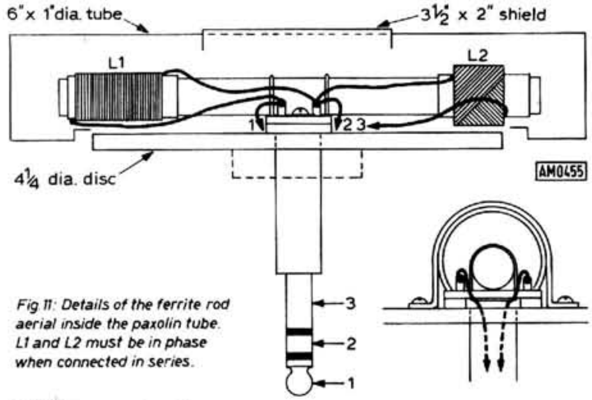
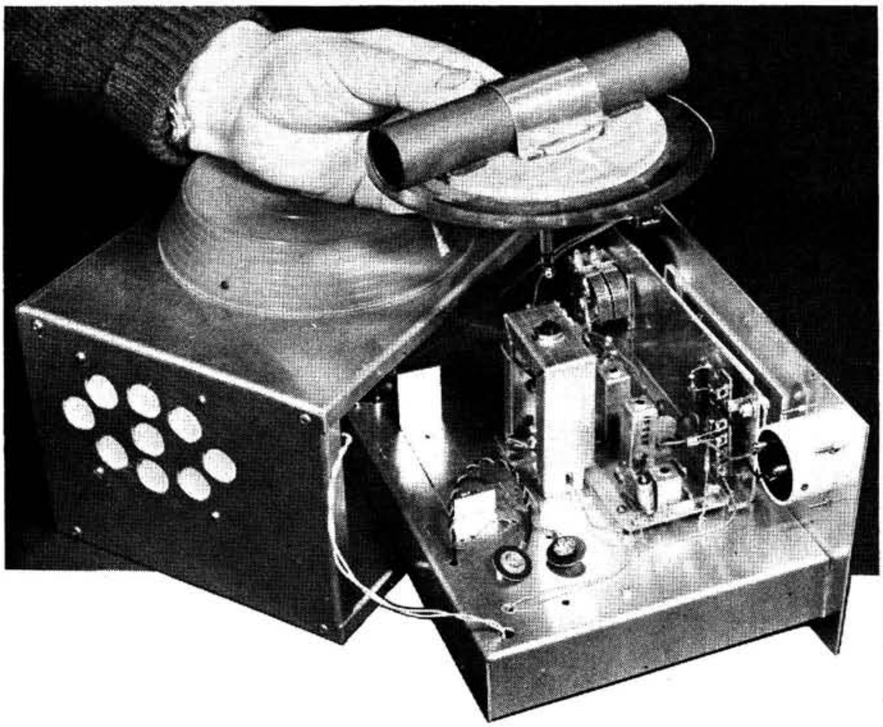


*Fig 11: Details of the ferrite rod aerial inside the paxolin tube. L1 and L2 must be in phase when connected in series.*

## Alignment

Band coverage is most easily checked if a signal generator is available, but satisfactory alignment is possible without this. The IFTs are pre-aligned by the maker so only small adjustments to these cores should be necessary and should not in any case be made until signals are received. A correctly shaped tool, such as that available from the IFT maker, must be used, otherwise the cores may crack.

To check the IFTs, tune in any steady, stable signal correctly, with VR1 near maximum gain, but reducing signal strength if needed by rotating the aerial, so that the meter does not go beyond full scale. All the IFT cores can then be adjusted slightly to give the best meter reading. When the IFTs are correctly aligned in this way, they must **not** be altered or readjusted when aligning the aerial and oscillator



*The ferrite aerial is mounted inside a paxolin tube and connected via a stereo jack plug. This permits the aerial to be rotated to find the 'Null' point.*

*continued on page 1080*

able (selectivity control at "wide") to include both sidebands of the transmitted signal. When trying to pick-out a weak DX signal in a crowded MW band, high selectivity is desirable to try to reduce adjacent channel interference. High selectivity leads to side-band cutting and loss of HF response at audio frequencies. Speech becomes muffled and difficult to follow. Intelligibility can be improved if the receiver it detuned slightly. Its IF passband now covers all one sideband instead of part of both, speech clipping is reduced while selectivity is maintained and cleaner and easier to understand speech will be the result. If the interference is coming from only one side of the DX then detune away from it. The strength of the unwanted transmission will be reduced while the level of the DX will be unchanged.

The second session of the International Telecommunications Union Conference on the future of medium and longwave broadcasting in Regions 1 and 3, which includes Europe, was held in Geneva last autumn. As expected, the 9kHz channel spacing in Europe is to continue though many channels on the medium waves will have their frequency increased by 1kHz so that they are multiples of 9kHz. Heterodyne interference will be reduced if each channel is harmonically related to the channel spacing. The UK is allowed two additional transmitters on the longwaves, both of which will be located in Scotland. One will be on 200kHz (1500m), the existing longwave channel and the other will be on 227kHz (1321m). They will come into use after the start of the new plan in November 1978.

The retention of the 9kHz spacing will continue to favour the DXer who is interested in reception of Region 2 (North and South America) where the spacing is 10kHz but the 1kHz change in Europe will bring its problems. Reception of KOMO in Seattle and WCFL in Chicago both on 1000kHz will become more difficult as the nearest European will now be on 999kHz. Whether there will be any compensating gains, remains to be seen.

Latin American medium wave stations, especially those situated along the east coast of South America, come in well in the UK. The long sea path across the North and South Atlantic favours propagation from Argentina and Brazil enabling some of the higher powered broadcasters in Buenos Aires and Rio de Janeiro to be heard at surprising strength at times. **D. R. Mayhew** (Littlehampton) has been chasing DX from this area between the hours of midnight and 0300 using a Philips receiver and a 20in loop with RF amplifier. He says "the Brazilians are very exciting and well worth waiting for" and he mentions hearing two broadcasts from Buenos Aires; Radio Belgrano on 950kHz and Radio el Mundo on 1070kHz and no fewer than five from Rio de Janeiro; Radio Mundial on 860kHz, Radio Jornal do Brazil on 940kHz, Radio Nacional on 980kHz, Radio Globo on 1180kHz and Radio Eldorado on 1220kHz plus Radio Record in Sao Paul on 1000kHz.

Portuguese is spoken in Brazil, a language that sounds a bit different from Spanish which is used in Argentina and the remainder of Latin America. The majority of Brazilian stations are commercial, owned often by newspapers. Musical programmes include the rhythms of the samba and bossa nova which beat out from trumpets, guitars and marimbas to entertain the distant DXer!

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circuits. Band coverage is determined by the settings of TC1, TC2, TC3, TC4 and the position of the oscillator coil core.

Aerial alignment is determined by TC5, VC3 and the positions of L1 and L2 on the rod. Correct alignment of the aerial tuning is shown by maximum meter reading. If VC3 enables a signal to be peaked up, and is not fully open or fully closed, alignment may be regarded as correct at that frequency. However, the settings of TC5, L1 and L2 must be approximately correct or the trimming compensation afforded by VC3 may be insufficient at some frequencies.

**Band 1.** With each band the low frequency end is reached with VC1/2 closed and the high frequency end with VC1/2 open. For this band, TC4 sets the HF limit and TC2 the LF limit. TC5 is set so that VC3 can be peaked as described and may need re-adjustment after dealing with Band 2.

**Band 2.** TC3 sets the HF band limit. With a signal tuned in near the HF end of the band, adjust VC3 for best volume or meter reading. Tune in a signal near the LF band end and move L1 on the rod for best signal level, leaving VC3 untouched. Check that VC3 can peak signals throughout the band.

**Band 3.** Oscillator coverage is independently adjusted by TC1 and L2 which is adjusted at the LF end of the band. A 60pF trimmer may be wired from pin 2 to pin 3, for LW trimming, but is not essential.

On all bands a small adjustment to the oscillator coil core setting will cause a substantial shift in frequency. So if this is made on any one band, the other two bands have to be checked again, as described. The actual coverage which is obtained can be modified quite substantially. It is not necessary that any particular bands are obtained by these adjustments, as other settings will result in no loss of efficiency, provided VC3 allows signals to be peaked up. The ranges actually provided were: Band 1: 1300-1500kHz; Band 2: 600-1300kHz; Band 3: 160-250kHz.

## In use

To locate the position of the receiver, bearings have to be taken from at least two transmitters whose positions are known. If these are plotted on a map or chart, the receiver will lie roughly at the intersection of the lines. A third bearing can be expected to give more accuracy and should confirm the first result. To locate the position of a transmitter, directional bearings on its signal have to be taken from two known positions. When these are plotted, their intersection shows the transmitter location.

Low frequency and ground wave signals will generally give quite accurate bearings. Ground wave signals are those which have not been reflected by ionised layers above the earth. Their useful range depends on power, frequency and other factors and may extend to fifty miles or more. Sky-waves, on the other hand, are those reflected down and they provide greatly increased range, especially for higher frequency signals after dark but they may give confused bearings. In coastal areas wavefront bending may cause a deviation of 10-15° while nearby metal objects or structures may also modify the apparent direction of a signal. For ordinary reception purposes, it is only necessary to rotate the aerial for best reception, or minimum interference.